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$.23 \div 6 = .03\frac{5}{6}$, amount gained in one year.

$.03\frac{5}{6} \div 1.05 = 3\frac{41}{63}\%$=rate of income.

Also solved by *P. S. BERG*.

95. Proposed by WALTER HUGH DRANE, A. M., Professor of Mathematics, Jefferson Military College, Washington, Miss.

A man sold a house for \$7,500 and gained a certain per cent. on the cost. If the cost had been $16\frac{2}{3}\%$ less, his gain would have been 25% greater. Find the cost of the house.

I. Solution by J. K. ELLWOOD, A. M., Principal of Colfax School, Pittsburg, Pa.; and M. A. GRUBER, A. M., War Department, Washington, D. C.

The increase in per cent. gained is made up from two sources: (a) additional *gain* caused by decrease in cost, and (b) original compared with supposed cost instead of actual cost.

$16\frac{2}{3}\%$ of cost÷(cost−$\frac{1}{6}$ cost)=$\frac{1}{5}$, or 20% of supposed cost.

Hence 25%−20%, or 5%, must be due to changing the *base*, and (gain÷$\frac{5}{6}$ cost)−(gain÷cost)=5%, or $\frac{1}{20}$, or gain÷5×cost=$\frac{1}{20}$, and gain=$\frac{1}{4}$ cost.

Hence $\frac{5}{4}$ cost=\$7,500, and cost=\$6,000.

Solution No. 2. The *rate* on $\frac{5}{6}$ cost=$\frac{6}{5}$ of rate on cost.

$\frac{1}{6}$ of cost÷$\frac{5}{6}$ cost=$\frac{1}{5}$, or 20%.

∴ $\frac{6}{5}$ of rate on cost+20%=rate on cost+25%, or $\frac{1}{5}$ rate=5%, and rate=25%.

Hence \$7,500=125% of cost, and cost=\$6,000.

Solution No. 3. Let $6x$=cost. Then \$7,500−$6x$=gain.

\$7,500−$5x$=supposed gain.

$$\frac{7500-5x}{5x}=\frac{7500-6x}{6x}+\tfrac{1}{4},$$ whence x=\$1,000, $6x$=\$6,000.

II. Solution by B. F. FINKEL, M. Sc., M. A., Professor of Mathematics and Physics, Drury College, Springfield, Mo.

1. *100* per cent.=selling price.
2. 100 per cent.=actual cost.
3. *100* per cent.−100 per cent.=gain.
4. 100 per cent.−$16\frac{2}{3}$ per cent.=$83\frac{1}{3}$ per cent.=conditional cost.
5. *100* per cent.−$83\frac{1}{3}$ per cent.=conditional gain.
6. $83\frac{1}{3}$ per cent.=100 per cent. of itself.
7. 1 per cent.=1/$83\frac{1}{3}$ of 100 per cent.=$1\frac{1}{5}$ per cent.
8. *100* per cent.−$83\frac{1}{3}$ per cent.=(*100*−$83\frac{1}{3}$) times $1\frac{1}{5}$ per cent.=$\frac{6}{5}$×*100* per cent.−100 per cent.=conditional gain per cent.
9. ∴ $\frac{6}{5}$×*100* per cent.−100 per cent.−(*100* per cent.−100 per cent.)=$\frac{1}{5}$×*100* per cent.=difference.
10. 25 per cent.=difference.
11. ∴ $\frac{1}{5}$×*100* per cent.=25 per cent.
12. *100* per cent.=5×25 per cent,=125 per cent.=selling price in terms of actual cost.
13. ∴ 125 per cent.=\$7,500.

14. 1 per cent. $=\frac{1}{125}$ of \$7,500 = \$60.

15. 100 per cent. = \$6000 = the cost of the house.

Also solved by *COOPER D. SCHMITT*, *F. R. HONEY*, *M. E. GRABER*, *EDW. R. ROBBINS*, *B. F. SINE*, *J. SCHEFFER*, *J. F. TRAVIS*, *EARL R. GIBSON*, *FREMONT CRANE*, *HENRY HEATON*, *J. H. DRUMMOND*, and *G. B. M. ZERR*.

Solved in a similar manner, though more briefly, by Walter H. Drane. Professor Drane has some doubts as to whether the above is strictly an arithmetical solution and asks the question, What is the exact difference between an arithmetical and an algebraic solution? This question I have answered in the last number of the MONTHLY. The above is not an arithmetical solution at all. Professor Ellwood's last solution is algebraic. My solution of problem 93, aside from the principles borrowed from geometry, is purely arithmetical, because all the operations are performed at once upon certain numbers and the results of these operations summed give the final result. The selling price is printed in italics for sake of distinction. [ED. F.]

ALGEBRA.

83. Proposed by J. MARCUS BOORMAN, Consultative Mechanician and Counselor at Law, Woodmere, Long Island, New York.

Solve $x^2+y=8$......(I) ; $y^2+x=60$......(II), true to four decimals.

I. Solution by G. B. M. ZERR, A. M., Ph. D., President and Professor of Mathematics, The Russell College, Lebanon, Va.

(I) in (II) gives $x^4-16x^2+x=-4$.

$\therefore x=-4,\ y=-8.\quad \therefore x=3.935432,\ y=-7.487627$;

$x=.537401,\ y=7.711199$;

$x=-.472833,\ y=7.776428$.

Solved similarly by *J. H. DRUMMOND*, and *EDW. R. ROBBINS*.

II. Solution by the PROPOSER.

[N. B. Change $\pm_1$......$\mp_1$ *only* in unison,—thus $S={}_1\pm(x+x_1)$ to $\Sigma={}_1\pm(y+y_1)$; $S_1=(x_1+x_{11})$ to $\Sigma_1=(y_1+y_{11})$; $S_a=(x+x_{11})$ to $\Sigma_a=\pm_1(y+y_{11})$, 12 roots.]

The "*Empirical*" gives (E) ....

$S^4-2[S\pm_1\sqrt{(8^2-60)}]S^2+Id^2=Id^2\pm_1\frac{1}{4}f\sqrt{[1/(8^2-60)]}$. ["$f$"=1, factor of x in (I) ; S=sum $x+x_1$; Σ=*co*-sum $(y+y_1)$, etc. *Analyst* for 1882, IX, page 122].

$f=f^2=1$..... $\therefore$

(III)......$S^2=10\pm\sqrt{100\frac{1}{8}}=10\pm10.0062484$.......$\therefore S=\pm4.472834{,}2+$,

(IV) ...... $S_1^2=6\pm\sqrt{35\frac{7}{8}}=6\pm5.9895761$. True $S=4.472833{,}9+$.

Error .....0.000000,3.

By (IV) $S_1=\pm3.462596{,}5$,—its reciprocal is $\Sigma_1=0.288800{,}4+$,

True $S_1=3.462598{,}42$. Reciprocal of S is $\Sigma=0.223571{,}9+$,

Error..... 0.000001,9 $\therefore S_a=0.064567{,}6$; $\Sigma_a=15.487627{,}6+$.

[Thus reducing the "ir-reducible" case]. Q. V. D.

By $\Sigma=f(1/S)$, $f=1=S\Sigma=SS_1S_a$. *Any* S or Σ will give, by

(A)......$x=\pm_1\frac{1}{2}S\pm\sqrt{[8-\frac{1}{4}S^2\mp_1\frac{1}{2}f(1/S)]}$. ($f=f^2=1$ here.)

(B)......$y=\pm_1\frac{1}{2}\Sigma\pm\sqrt{[60-\frac{1}{4}\Sigma^2\mp_1\frac{1}{2}f^2(1/\Sigma)]}$, the whole *eight* roots, viz.:

$x=0.537401+$, $x_1=3.935432$, $x_{11}=-0.472833{,}9$, $x_a=-4$;

$y=7.711199+$, $y_1=-7.487627$, $y_{11}=7.776428{,}1$, $y_a=-8$.